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United States Department of Agriculture,

BUREAU OF ANIMAL INDUSTRY.

THE DIRECT TRANSMISSION OF INFECTIOUS ENTERO-HEPATITIS IN TURKEYS.

The organs from diseased turkeys received at this laboratory during the summer and fall of 1895 show that infectious entero-hepatitis (black-head) of turkeys is not restricted, as formerly supposed, to the States bordering on the New England coast, but that certain flocks in the Middle and Western States are affected with it. The data obtained bearing upon the geographical distribution of the disease indicates that it is gradually extending into the Western States. It has not yet been found in the Southern States. For want of statistics the amount of loss to the poultry industry occasioned by this disease can not be accurately estimated, but the fact that it has caused many farmers and poultry men in New England to discontinue the raising of turkeys shows that it is of much economic importance. It is stated in the report of the Rhode Island Agricultural Experiment Station for 1894 that "the eradication of this disease would be worth hundreds of thousands of dollars to the Eastern farmers alone." These heavy losses in the East, together with the accumulating evidence that the entire northern third of this country is sprinkled with infected districts from which the disease is spreading, render the determination of the means by which this dissemination occurs a matter of more than ordinary significance to those engaged in the turkey industry.

NATURE OF THE DISEASE.

Prior to 1894, the nature of this disease was unknown. In the fall of 1893, Prof. Samuel Cushman, of the Rhode Island State Experiment Station, sent a few specimens of the diseased organs of turkeys which had died of "black-head" to this laboratory where they were carefully examined by Dr. Theobald Smith. In the summer of 1894, Dr. Smith made a careful study of this disease at the Rhode Island Experiment Station. He found that it was caused by one of the protozoa (*Amœba meleagridis* Smith) and he published¹ a full description of the disease which, in accordance with the lesions, he designated infectious entero-hepatitis.² This report shows that the disease usually attacks the young turkeys. The walls of one or both cæca become thickened, and the liver is mottled with

¹An infectious disease among turkeys caused by protozoa (infectious entero-hepatitis.) (Bulletin No. 8, Bureau of Animal Industry, U. S. Department of Agriculture, Washington, D. C., 1895.)

The popular term "black-head" refers to the darkened appearance of the heads of the turkeys affected with this disease. This symptom is said to occur in cases of other intestinal troubles of turkeys.

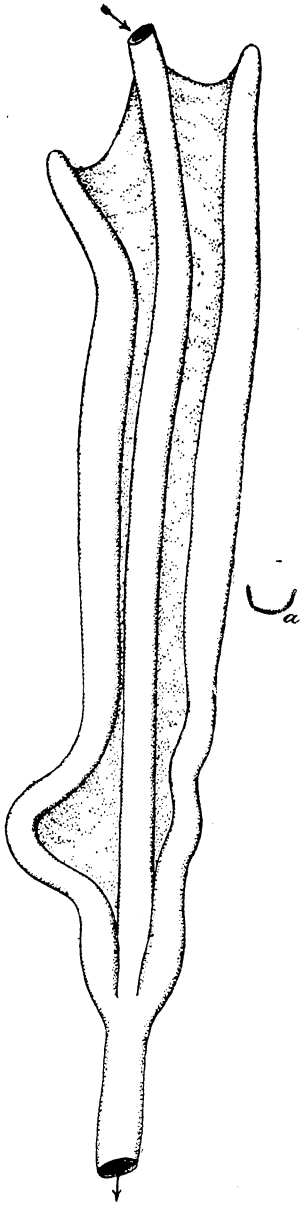


FIG. 1.—Caeca of healthy turkey weighing about 7 pounds. The central tube is the small intestine, the food passing downward in the direction of the arrow. At the junction of the caeca with the intestine, the food is drawn into the caeca by suction. The thickness of the caecal wall is shown in *a*.

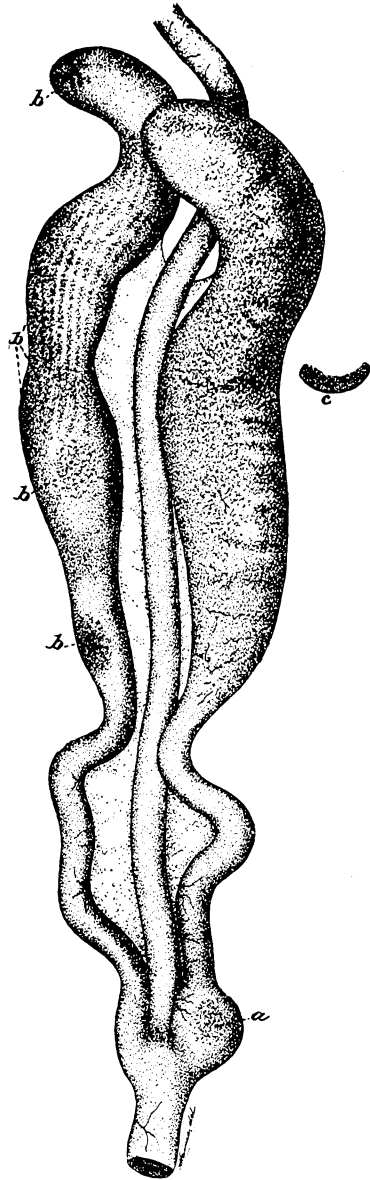


FIG. 2.—Caeca of turkey No. 7 in which the protozoan disease was produced. The upper two-thirds of one caecum is affected, also an area, *a*, near the union with the colon. The other caecum is thickened at the points *b*. The thickness of the affected caecal walls is shown in section *c*. (Reduced one-third.)

areas of varying size, having a brownish, yellowish, or perhaps greenish color. These peculiarly colored areas in the liver are of diagnostic value, as they have not been found in other caecal or intestinal troubles. The microscopic examination of the affected parts showed the presence of large numbers of the protozoa in the cells and intercellular tissue. The life history of this parasite and the way by which the turkeys become infected with it were not determined, but from the facts elicited, Dr. Smith¹ thought it highly probable that the micro-organism is transmitted from turkey to turkey without passing through an intermediate host.

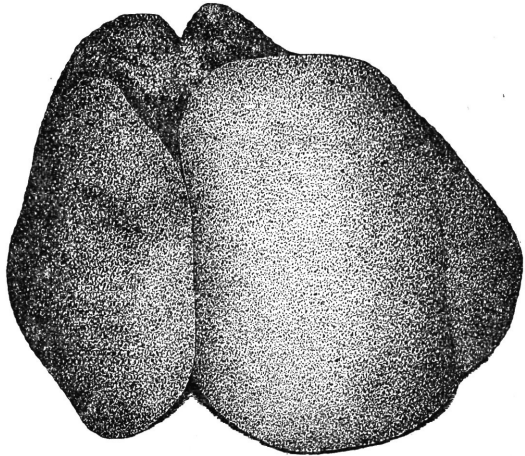


FIG. 3.—Liver of a healthy turkey weighing about 7 pounds.

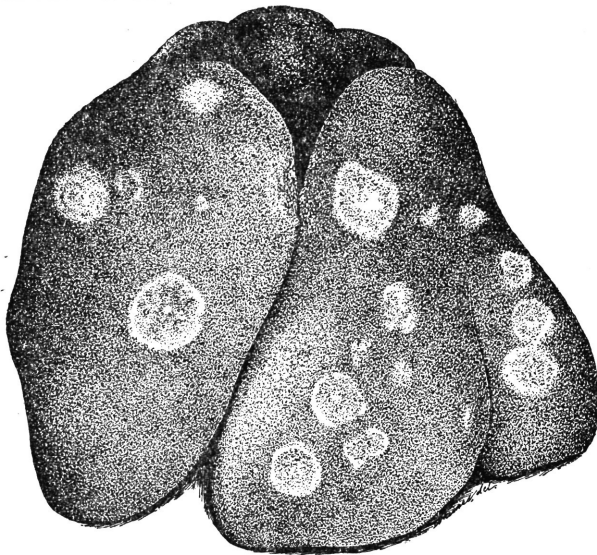


FIG. 4.—Produced protozoan disease. Liver of turkey No. 5 showing discolored areas, or spots. (Reduced one-third.)

The nature of the disease indicates that inquiries into the means by which it is transmitted, with the object of determining methods for its prevention, promise more speedy and practical results than investigations into its medicinal treatment. Furthermore, it is of much importance that its spread into noninfected localities should be checked. To accomplish this, it is first necessary to demonstrate whether the specific microparasite is, as supposed by

¹ Concerning the transmission of this disease Dr. Smith makes the following statements: "From our present standpoint I think it safe to assume that the microparasite is transmitted from bird to bird without passing through any intermediate host. The microparasite, discharged perhaps in an encysted stage from the sick bird, is taken up with the food and water by others and sets up the disease directly. If the parasites were taken up with insects, for example, we should expect to find the disease diffused through all the flocks. But even the limited experience of last summer leads me to believe that certain flocks only are infected, and that by uninterrupted transmission the disease becomes perpetuated and diffused among neighboring flocks. The perpetuation of the parasites, I am inclined to think, is to be sought for in the older turkeys, which carry them in their bodies, most likely in the digestive tract, during the winter. This view is supported by the fact that turkeys not infrequently recover from the disease. This recovery does not mean, however, the destruction of the parasite within the body, for we have now information concerning the persistence of a variety of parasites—bacteria and protozoa—within the body long after recovery."

Dr. Smith, directly transmitted from turkey to turkey by feeding from the ground soiled by the feces of affected turkeys. It is the opinion of many turkey raisers that the disease is contracted either by eating certain insects or by drinking from stagnant pools. In October, 1895, a special inquiry was made into the conditions under which the disease occurs in Rhode Island for the purpose of arranging

experiments to determine the source of infection and the transmissibility of this affection.

It was learned that there was much less of this disease among turkeys in the summer and fall of 1895 than there had been in previous years. The statement was also made by a large number of turkey raisers that an unusually large number of old turkeys had died in the spring of 1895. This clinical history suggested the possibility that many of the old turkeys which were affected with a chronic form of the disease had succumbed to it in the spring, thus cutting off the channel through which the young might otherwise have become infected later in the season.

The distribution of the disease in Rhode Island was found to be somewhat peculiar, as there are many localities in which it has never been known to occur. From the statements of the farmers, however, it appears that these noninfected districts are being gradually invaded and that occa-

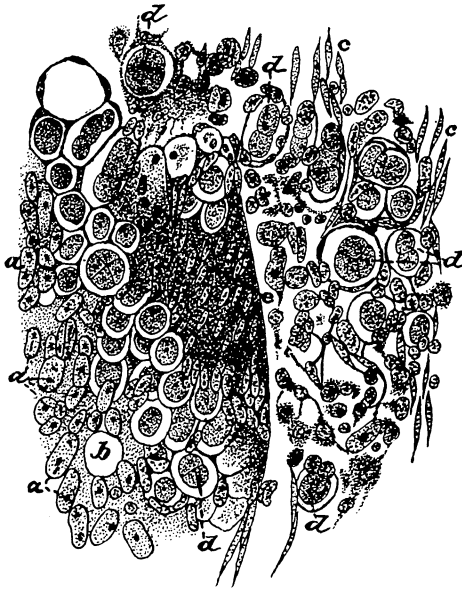


FIG. 5.—A portion of the mucous membrane of an affected caecum cut transversely. *a*, Nuclei of epithelium. *b*, Mucin represented by a cavity in the section. *c*, Spindle-shaped cells belonging to the interlobular tissue. *d*, Protozoa, single and in compact groups, situated within the meshes of the reticulum. *e*, Multinucleated (giant) cell which has enveloped some of the protozoa. (After Smith.)

sionally the disease appears on a farm within the territory supposed to be exempt. Professor Cushman states that on many farms turkeys are raised without loss, while the flocks on those a mile distant are seriously affected. Several farmers stated that they had raised turkeys for years without suffering from the disease but that soon after it appeared in their neighbors' flocks it could not be kept out of their own.

Another feature worthy of consideration is the appearance of the disease on farms where turkeys have not been kept for several years prior to the present effort to raise them. In one instance the owner reported that turkeys had not been kept on the place for eleven years prior to 1893. In the spring of that year, a few turkeys were purchased from a flock supposed to be perfectly healthy. In

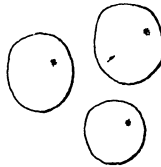


FIG. 6.—The protozoan parasites as they appear in crushed and teased fresh tissue, magnified 1,000 diameters. (After Smith.)



FIG. 7.—Protozoan occupying space formerly occupied by liver cells. Much enlarged. (After Smith.)

the fall a few of the young turkeys died of black-head. The following year a larger number of deaths occurred, and at the time this farm was visited, at least 80 per cent of a large flock was affected. The examination of a few turkeys which had died during the preceding few days confirmed the accuracy of the diagnosis. It should be remembered that turkeys are prone to wander and it is highly probable that the first birds which had the disease in 1893 became infected, if the stock was healthy, from turkeys on neighboring farms where the disease did exist, and that one or more of the infected birds were wintered, thus establishing the disease in the flock. A similar history was obtained from other farmers. While other means of transmitting the microparasite are possible, the facts elicited concerning the appearance of the disease in a large number of flocks could be explained on the hypothesis of the direct transmission of the parasite.

A feeding experiment with the excrement and viscera of diseased turkeys was arranged late in November. The statement that it was practically impossible to recognize the disease in the spring rendered it desirable to make the initial experiment early in the winter, notwithstanding the fact that nearly adult turkeys would have to be used for the exposure. Through the efforts of Professor Cushman, three presumably affected turkeys were obtained. Dr. E. C. Schroeder secured in the District of Columbia healthy turkeys about five months old, each weighing from six to eight pounds. With these turkeys, the following feeding experiment was conducted at the Experiment Station of the Bureau, under the immediate supervision of Dr. Schroeder:

FEEDING HEALTHY TURKEYS WITH THE EXCREMENT AND VISCERA OF TURKEYS AFFECTED WITH INFECTIOUS ENTERO-HEPATITIS.

November 27, 1895, three turkeys (Nos. 1, 2, and 3) were received from Rhode Island.

Turkey No. 1 was dead upon arrival. The post-mortem examination showed extensive lesions characteristic of the protozoan disease. Sections of the affected organs revealed the presence of the specific parasite.

Turkey No. 2 died during the night of December 1. It exhibited lesions similar to those found in turkey No. 1.

Turkey No. 3 appeared to be sick upon arrival, but soon improved and at this writing is apparently well.

The living turkeys were taken to the Experiment Station November 28. As one of the turkeys was dead upon its arrival it was decided to divide the experiment into two parts, namely, (1) feeding the liver and cæca of the dead turkeys to healthy ones, and (2) exposing healthy turkeys in a small yard to the surviving Rhode Island turkeys. In order to be sure that the healthy turkeys ate the food soiled with the excrement from the sick ones, the affected birds were separated at night and their feces collected and thoroughly mixed with the corn and wheat fed to the well ones on the following day.

Two healthy turkeys (Nos. 8 and 9) were fed the liver and cæca of turkeys Nos. 1, 2, and 12.¹ The affected organs were chopped into fine pieces, mixed with the food, and fed daily in small quantities until consumed. The dates of feeding the viscera are as follows:

Nov. 28.² Turkeys Nos. 8 and 9 fed liver and cæca of turkey No. 1.

Dec. 3. Turkeys Nos. 8 and 9 fed liver and cæca of turkey No. 2.

Jan. 3. Turkeys Nos. 8 and 9 fed liver and cæca of turkey No. 12.

Autopsy notes.—Turkey No. 8 was found dead January 11. The liver contained several small areas of a yellowish color. One cæcum was enlarged and the serous

¹ Turkey No. 12 was one of a lot of diseased turkeys received from Professor Cushman early in January, 1896.

² These are the dates upon which the feeding began, but the consumption of all the material required from two to three days in each case. It should be stated, however, that very little if any of the viscera of the first case was eaten.

surface sprinkled with several quite large areas covered with a grayish exudate. The caecal wall was thickened and the mucosa necrosed over several areas. Contents of a semi-liquid nature and blood-stained. The other caecum was normal. The disease in the caecum and liver was very acute. The protozoa were found in the thickened caecal wall.

Turkey No. 9 appeared to be well January 13 and was killed for examination. The caeca were normal, but the liver was sprinkled with a large number of small, (1-2 to 2 mm. in diameter) gray, brown, and greenish colored areas. Sections of the liver showed excessive fatty degeneration, but the specific organism of the protozoan disease was not found.

In the other part of the experiment four healthy turkeys (Nos. 4, 5, 6, and 7) were penned, November 28, with the two surviving Rhode Island turkeys (Nos. 2 and 3). They were also fed daily, beginning November 29, upon the excrement of turkeys Nos. 2 and 3 for three days when turkey No. 2 died. For two weeks subsequently they received in their daily rations the feces dropped during the previous night by turkey No. 3. The outcome of this exposure was as follows:

Turkey No. 4 died December 20, 1895, of infectious entero-hepatitis.

Turkey No. 5 died December 25, 1895, of infectious entero-hepatitis.

Turkey No. 6 killed January 13, 1896, not apparently affected.

Turkey No. 7 killed January 13, 1896, extensive lesions of infectious entero-hepatitis.

Autopsy notes.—Turkey No. 4 died of the protozoan disease during the night of December 20. The liver was sprinkled with several areas of a yellowish-brown color 4-12 mm. in diameter. The intervening tissue closely sprinkled with grayish points. The mucosa of the duodenum and ileum hyperæmic. The walls of the caeca were thickened and agglutinated together. The mucous membrane of the caeca was hyperæmic, with several quite large areas over which the mucosa was necrosed.

Turkey No. 5 died late in the afternoon of December 25. It was examined December 26. The liver contained several areas of necrosed tissue of a yellowish-brown color. The walls of the caeca were very much thickened and agglutinated together and to adjacent portions of the intestine. Protozoa were found in sections of the caeca.

Turkey No. 6 appeared to be well January 13. It was killed for examination. The organs were normal in appearance.

Turkey No. 7 appeared well and in good flesh January 13. It was killed for examination. The liver contained many yellowish and brown areas. The walls of both caeca were thickened. The serosa of one caecum was covered with a thin grayish exudate. Blood vessels injected. This turkey would undoubtedly have died of the protozoan disease within a few days.

The absence of the disease in the turkeys used in this experiment is assured by the fact that Dr. Schroeder witnessed the killing and carefully examined the viscera of six other turkeys from the same flock, all of which were perfectly normal. In addition to this the disease has not been found in the District of Columbia, or in the States of Maryland and Virginia. In February, 1895, Dr. Smith examined the caeca of about 30 turkeys from the Washington market without finding the disease, and in the fall of the same year a number of others from the same source were examined by the writer with similar results.

The disease in each of the four undoubted cases (turkeys Nos. 4, 5, 7, and 8) of the protozoan disease produced by feeding was similar to that found in the turkeys described by Dr. Smith in both the nature and the distribution of the lesions. The lesions were more recent than those which I found in Rhode Island, indicating that the produced disease was more acute than when it occurs under more natural conditions. The liver of turkey No. 9 indicated the early stage of an extensive invasion, although the presence of the microparasite was not demonstrated. The absence of the disease in one of the turkeys (No. 6) fed with the feces is not difficult to explain. It must be remembered that the four turkeys (Nos. 4, 5, 6, and 7) were fed feces of but one turkey (No. 2) known to have had the disease, and with these for only three days. Turkey No. 3 appears not to be affected and it has

not been sacrificed to determine this point, as it is desirable to demonstrate, if possible, the disease in old turkeys in the spring. The fact that four typical cases of the disease were produced is ample evidence of the direct transmission of the parasite. It is also important to note that in this experiment the disease was produced in nearly adult turkeys.

Early in January eight more turkeys, presumably affected with the protozoan disease, were received from Professor Cushman, and other experiments are being made to test the communicability of the disease to other species of poultry, the efficiency of disinfectants, and the length of time the microparasite will remain alive in the feces. The results of these investigations, however, will not be ready for publication until too late in the season to render them of value in dealing with infected flocks this spring. As the amount of this disease among turkeys in 1895 was unusually small this seems to be an opportune time to make strenuous efforts to eliminate the diseased stock and thus avoid the direct infection of the forthcoming flocks.

SUGGESTIONS CONCERNING PREVENTION.

The practical teaching of this experiment is obvious. If the method of direct infection proves to be the only means of transmission, the extermination of the disease is possible. It is impossible, however, to give positive directions concerning the management of diseased flocks, or at present healthy ones, within the infected localities, until further facts are obtained relating to infection other than from turkey to turkey. The practical solution of this question rests largely in the future experience of those farmers who eliminate the possibility of direct infection. From our present knowledge of the transmission of this disease it is suggested that farmers and poultry raisers who have recently had this disease in their flocks should dispose of their old turkeys and start by hatching turkey eggs under hens or with turkeys obtained from noninfected districts, preferably from the South as this disease is not known to exist there. As a precautionary measure the turkey roosts, especially the accumulated droppings, should be disinfected early in the spring before the young turkeys are hatched or old ones introduced. The liberal use of slaked lime in the yards most frequently occupied by the diseased turkeys is recommended. A serviceable disinfectant for buildings and places containing the feces of diseased turkeys is the following:

Crude carbolic acid.....one-half gallon.

Crude sulphuric acid.....one-half gallon.

"These two substances should be mixed in tubs or glass vessels. The sulphuric acid is very slowly added to the carbolic acid. During the mixing a large amount of heat is developed. The disinfecting power of the mixture is heightened if the amount of heat is kept down by placing the tub or glass demijohn containing the carbolic acid in cold water while the sulphuric acid is being added. The resulting mixture is added to water in the ratio of 1 to 20. One gallon of mixed acids will thus furnish 20 gallons of a strong disinfecting solution, having a slightly milky appearance. It is quite corrosive, and care should be taken to protect the eyes from accidental splashing."

It is hoped that the results of experiments now under way here and at the experiment station of Rhode Island will enable definite and positive answers to be given to pending questions concerning the duration of the vitality of the specific microparasite in feces and soil, the use of disinfectants, and whether infection takes place in the absence of diseased turkeys.

It is important that care should be taken not to spread the disease by transporting affected turkeys from an infected locality to a noninfected one. The history of the disease indicates that it has thus become so widely disseminated.

Until the life history of the parasite is determined it is impossible to say that this is the only cause of its appearance in different localities. It is not known whether wild turkeys are affected. Pending the results of investigations now in progress it is of the highest importance that the communicability of this disease through the excrement of affected turkeys should be recognized, and vigorous measures adopted to prevent its further spread by this means. Even if other sources of infection be found, future investigations will doubtless prove that the great majority of the turkeys attacked become infected through the direct transmission of the parasite.

Very respectfully,

VERANUS A. MOORE,
Chief of the Division of Animal Pathology.

Approved:

J. STERLING MORTON,
Secretary.

WASHINGTON, D. C., *March 11, 1896.*